ADAPTIVE ECOSYSTEM MANAGEMENT

IN THE

CALFED BAY/DELTA RESTORATION PROGRAM

WHAT IS ADAPTIVE ECOSYSTEM MANAGEMENT

Ecosystem management is the process of taking actions to preserve, sustain, enhance, and restore ecological resources and human needs of an ecosystem such as the Bay/Delta. "Adaptive" Ecosystem Management is adjusting this management process as the process unfolds and results are obtained (Holling 1978; Walters 1986; Lee 1993). It is an interactive approach to decision making. It involves a cycle of goal setting, describing actions to achieve those goals, planning, implementation, monitoring, research, and subsequent reexamination of the actions. Ecosystem managers assess information gathered from monitoring and research and adjust plans if necessary. In the ecosystem health vernacular, ecosystem managers diagnose, treat, monitor response to treatment, and then adjust the treatment regime as needed.

Adaptive management is a process that should involve stakeholders and resource managers working together in redirecting program actions in response to changing social, economic, and ecological information (Holling 1978; Walters 1986; Walters and Holling 1990). Because of the difficulties and uncertainties involved in ecosystem management, adaptive management has been suggested and widely adopted as the standard approach to ecosystem management (Everett et al. 1994). Adaptive management is a key component of ecosystem management as it provides a decision support system for stakeholders and resource managers (Wondolleck 1988). It deals with uncertainties of implementing ecosystem management through the conduct of focused experiments with rapid feedback of information (Everett et al. 1994).

"*Adaptive management promotes the integration of social, economic, and ecological issues in land management planning and their expression in landscape patterns of resource values. Adaptive management addresses risks and uncertainties by increasing opportunities to redirect management with new information.*" (Everett et al. 1994)

Key elements essential to a successful adaptive management program are goals/objectives and a monitoring plan. Program goals and objectives should be well defined, and should not be adjusted in the event success is not achieved, only the implementation approach should be changed. The state of health the program hopes to achieve should not change, only the treatment program need be changed to ensure health goals are achieved. Monitoring data are examined and reexamined with these goals and objectives in mind.

Effective adaptive management requires well-defined success criteria; long-term comprehensive monitoring plans; comprehensive restorations plans; and a cooperative management team.

NEED FOR ADAPTIVE MANAGEMENT

The primary need for adaptive management is to provide a process that maximizes the potential success of a restoration program. Adaptive management provides a process of actions, monitoring, evaluation, and readjustment that helps to insure program goals and objectives will be met. It provides for rapid feedback of information and adjustments in program actions and implementation levels to keep the program on track. Adaptive management helps in dealing with the inherent uncertainties of complex ecosystems. When causes of specific ailments are unknown and difficult to diagnose, then the solution may becomes evident from the response to treatments. Adaptive management provides needed feedback on the treatment regime and dose required. In ecosystem restoration programs there is often the questions of how much habitat and to what extent it should be restored. Adaptive management provides for experiments and monitoring to address these questions. There may also be questions on techniques and engineering feasibility to resolve. Pilot studies and experiments can provide an arena in which to work out the technology bugs and refine methods.

FLEXIBILITY

Adaptive management provides for flexibility in the restoration program. It allows a step by step approach where solutions can be implemented in phases for cost or technical reasons. Flexibility comes from the ability to adjust the program as needed.

UNCERTAINTY

Uncertainty about the future can be addressed with adaptive management. Change is likely with increases in development, greater water diversions, changing land use, demographics, economy, and values. Weather and rainfall are also uncertain. Even such things as global warming with its accompanying sea rise are changes to be considered. Further invasions of exotic species are likely. Since we can not be sure how such change will occur, we must adapt to the changes as they occur. Whether the future is chaotic or potentially predictable, adaptive management provides a solution.

Lack of sufficient knowledge on complex ecosystems such as the Bay-Delta can bring uncertainty to a restoration program that can be alleviated through adaptive management. Specific hypotheses can be tested in experimental actions to further understanding of the underlying cause-and-effect mechanisms that control the target ecosystem. There may be many hypotheses to test before the program can proceed toward success. Probing into uncertainty with experiments may provide information needed. With unknown ailments, combinations of diagnosis and treatments may be prescribed, and responses monitored through key vital signs or indicators. More serious ailments may require more aggressive or even experimental treatments.

There is also uncertainty relative to the potential benefits and costs or indirect effects of specific actions. Actions may fail to achieve goals and there will be a need to shift direction to meet goals. Technical feasibility may be in question for specific actions. We may not know how to implement an action. The potential effectiveness of specific actions may also be in question. A phased or experimental approach would allow some action to be directed toward problems before there is complete agreement on the overall solution. Diverse positions may require multiple approaches toward solving specific problems.

An adaptive approach also helps to overcome uncertainties related to state, federal, and local restrictions and regulatory requirements by implementing programs in small digestible doses.

RISKS

The potential for risk or failure increases with uncertainty. Adaptive management is an effective tool to minimize risks in a ecosystem restoration program. Risks such as indirect effects of actions can be identified from test programs. For example, increasing flows in one season usually means decreasing flows in another. Testing programs can identify risks with minimal impacts. Permanency of actions and reversibility are minimized under an adaptive management approach. We should be particularly aware of actions that preclude future options. With stakes high and funding limited, adaptive management provides a cautious and potentially reversible approach.

VERIFICATION OF GOALS

Testing and monitoring under adaptive management provide for the essential verification of meeting goals and targets.

FUNDING

Adaptive management provides opportunities to fund the program in stages. Commitments are often easier to obtain after each stage is proven successful and optimism builds for the next. Opportunities for cooperative funding or combining programs also come up that may improve the overall funding and potential success of the program. Unprofitable expenditures are limited. Costly long-term commitments that provide little or no benefit are avoided.

EQUITY

Adaptive management allows for the periodic adjustment of equity in an ecosystem management program that could otherwise become unbalanced. Staging decisions and direction as well as funding and implementation levels allows for consideration of equity toward resource uses.

STAKEHOLDER INVOLVEMENT

Adaptive management allows stakeholder involvement and resolution of potential disagreements. It allows for consensus and collective strategy, and opportunities to contribute knowledge and resources to problems. It also provides an ability for those involved to weigh risks and benefits of actions. Such balancing usually benefits from cooperative stakeholder involvement.

SOCIAL AND POLITICAL REALITIES

Adaptive management allows for including social and political realities to be incorporated into the restoration program.

POTENTIAL DRAWBACKS OF ADAPTIVE MANAGEMENT

There are a number of potential drawbacks of adaptive management.

- Small test efforts may not provide sufficient testing of the diversity of important ecosystem functions in a complex ecosystem such as the Bay-Delta.

- Delays in implementation in a phased approach could allow declines in the health of important ecosystem components.

- Benefits of some aspects of the program may be a long time in coming or may not even be detectable, which may lead to dropping valuable program elements.

- Information and analytical needs of adaptive management are extensive, and thus the potential need for large amounts of monitoring and research.

- Funding for an uncertain future and for the necessary monitoring and research may be difficult to obtain.

- Obtaining consensus and management direction and support on future course of actions at decision points in the future may be difficult.

ECOSYSTEM MANAGEMENT AND THE NEED FOR ADAPTIVE MANAGEMENT IN CALFED BAY/DELTA PROGRAM

The CALFED Bay-Delta Program has chosen to approach restoration of the Bay-Delta from an ecosystem perspective, because of the system's large size and complexity. The traditional piece-meal approach of addressing multiple local area restorations will not work in a large complex and integrated ecosystem such as the Bay-Delta and its upstream watersheds. This has been quite apparent to those involved with the Bay-Delta problems over the past several decades, and adaptive management has been a common practice to date at least at the individual project level. Previous efforts at adaptive management such as the State Board standards process had too narrow a focus to provide ecosystem level restoration. The CALFED program offers an opportunity to extend this approach to restoration of the ecosystem at the basin level with a much broader focus.

The goal of the program is to prevent further deterioration of the Bay-Delta ecosystem and to restore as much of the ecosystem health as possible. Knowledge and funding are needed to accomplish this goal. However, since knowledge and funding are limited resources, adaptive management will maximize the efficiency and cost effectiveness of the effort.

Adaptive management is a necessity of the CALFED Bay-Delta Program, because of uncertainties with regards to the causes of the ills of the Bay-Delta ecosystem and the inability to predict responses to proposed remedies and actions. A substantial number of the CALFED proposed actions will necessarily be implemented as "experiments" because of highly uncertain outcome and benefit. Actions may have a specific targeted resource, but the response is uncertain. For example, identified declines in many fish populations have been related to combination of diverse factors with the cause-and-effect mechanisms and roles of each factor being relatively unknown. Fish declines coincide with changes in flow and habitat conditions; the specific role of each is unknown. Experiments will be needed to direct the program in the direction of actions that provide the best return to the fish populations.

Because of the difficulties in answering these questions, the program will proceed based on available information and theories. Adaptive management will test these theories through trial and error experiments, rather than the wholesale implementation of actions. Testing will take the form of pilot studies or experiments.

With limited resources (e.g. dollars, land, water, time) a careful approach is necessary for success. Priorities and degree of experimentation in the program will depend on the extent to which each resource is limited. With many possible directions toward restoration, those routes with the most promise and equity must be found. Solving Bay-Delta ecosystem problems with more flow would seem a simple solution. The challenge will be to find a solution that is equitable, balanced, and least costly. Coming up with such a solution will require knowledge of factors and interactions that presently does not exist. Strong focused first steps with course corrections along the way will be the key to success.

Not all actions will be experiments. Some early steps will be readily known solutions to serious problems that have already been identified (core actions). Even core actions such as screening unscreened diversions may require some degree of experimentation to work out cost and engineering feasibility, as well as ecological considerations.

Adaptive management will allow more focus on ecosystem functions: those factors that are key in supporting populations of important fish and wildlife. This is essential for successful ecosystem restoration.

Adaptive management will also provide more focus on geographic differences and watershed units. The experimental approach focuses on specific watersheds or watershed units. Focusing intensively on a watershed provides a comprehensive view of the status and behavior of program actions without the need to extend efforts to the entire system. Upon testing, the program can be expanded within a watershed and to other watersheds.

In the overall restoration program, adaptive management should be implemented on a project-by-project basis, as each project may have its own specific needs for monitoring and research, as well as risk and uncertainty with regard to technical feasibility and cost.

An adaptive management approach will mean the program will proceed on a broad front. There will not be single large actions early in the program. Rather there will be many pilot and experimental projects at the watershed level that test the effectiveness and technical feasibility of actions. As the program matures, more larger scale project will come about as information is gained from early experiments. This approach will not preclude early implementation of large scale projects that already have a sound technical basis and need developed. There is considerable information available to implement an adaptive approach immediately for some program elements. Review and analysis of such information may preclude the need for some "experiments".

To be ultimately successful, adaptive management in the CALFED program will have to have institutional structures in place to carry out the program, to get funding, and to make the necessary decisions and changes that are necessary at future forks in the road. The CALFED program will be developing the supporting institutions from its base of agencies and stakeholders committed to the program.

REQUIREMENTS OF THE ADAPTIVE ECOSYSTEM MANAGEMENT PROGRAM

TARGETS/GOALS

A vision for the future in terms of targets and goals is needed to guide the adaptive management program. Each target or goal becomes the basis for an experiment to test mechanisms for achieving the goal.

TIME FRAMES

Targets and goals need time frames based on critical needs of important resources. An array of time frames helps set the terms of the adaptive management experiments.

MONITORING

Monitoring is an essential part of adaptive management. It provides information on the relative success toward reaching goals and provides key information on the process (e.g. costs, risks, schedule).

RESEARCH

Like monitoring, research is an important element of adaptive management. Research may be needed to develop effective monitoring techniques, or to test techniques that have uncertain outcomes.

MODELS

Because of the lack of available information and understanding on complex ecosystems, ecological modeling tools can be valuable in an adaptive ecosystem management program. Models are used to predict system responses through manipulation of controlling or limiting factors based on available information or theory. Models can help guide the program toward areas of uncertainty and document what is learned. Uncertainties can be built into a model and then tested through direct manipulation of the ecosystem. Models also need verification through experiments. Models also test the accuracy of information being used in the program. Models can also simulate various possible outcomes to provide a measure of uncertainty.

Everett et al (1994) suggest using simple risk analyses models to assist decision makers in determining the relative success of experiments toward goals and objectives. As with any models, the assumptions and conclusions should be verified for the model to be a successful tool in managing the future.

DELPHI APPROACH

Lack of information calls for a Delphi Approach wherein experts or stakeholders are asked to provide guesses as to outcomes or questions. Details of program, specifications, level of implementation, time tables, and geographic factors may require delineation for the restoration program to proceed. Hypotheses should be developed for tests.

GIS

Geographical Information Systems provide a means for storing, analyzing, and presenting spatial information from the program for use in the decision support system portion of the adaptive management program.

INFORMATION MANAGEMENT

With so much information being decimated and reviewed, tools such as the Internet through the World Wide Web offer excellent means of communicating the results and decisions of the program. Such tools also help to keep the public informed and educated.

INSTITUTIONAL STRUCTURE

An institutional structure will be needed to carry out the adaptive management program in the future. Such a function could be directly provided by CALFED or an independent institution formed to conduct this task for CALFED.

LITERATURE CITED

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